deterioration in MR ratio will still fluctuate. The second measure is to compensate for this, for which the material for the antiferromagnetic film is specifically defined. When the antiferromagnetic film is FeMn, the thermal deterioration is 30 %. However, when it is IrMn, the thermal deterioration could be reduced to 0 to 15 %. The MR ratio in the as-deposited film in which is used antiferromagnetic PtMn could not be measured, but the MR ratio in the film after thermal treatment is equal to that in the as-deposited film with IrMn. Namely, the thermal deterioration in MR ratio in the film with PtMn is almost 0 %. The thermal stability to MR ratio depends on the noble metal content of the antiferromagnetic film. It has been found that antiferromagnetic films containing a noble metal, for example, those of IrMn, PtMn, PdPtMn or RuRhMn are especially preferred for the spin valve films of the invention comprising an ultra-thin free layer.

Summarizing the above, Fig. 4 is a graph concretely showing the range of the pinned layer thickness and the nonmagnetic high-conductivity layer thickness in Synthetic AF for realizing asymmetry of from -10 % to +10 %, or that is, for realizing bias points of from 30 % to 50 % by our simplified calculation method. The "asymmetry" is defined as (V1 - V2)/(V1 + V2), in which V1 indicates the peak value of the reproduction output in a positive signal field and V2 indicates the peak value of the reproduction output in a negative signal

field. The "asymmetry of from -10 % to +10%" corresponds to "(V1 - V2)/(V1 + V2) falling between minus 0.1 and plus 0.1".

For realizing Hpin - Hin = Hcu, Hcu must be lowered when Hpin is small. In other words, as in the formulae (1-4) and (1-5), when the thickness of the upper and lower films of the pinned layer in Synthetic AF, (Ms×t)pin, is small, the thickness of the nonmagnetic high-conductivity layer must be large; but, on the other hand, when (Ms×t)pin is large, the thickness of the nonmagnetic high-conductivity layer must be small.

Concretely, the spin valve film with Synthetic AF of the invention shall satisfy the conditions of 0.5 nanometers ≤ tm(pin1) - tm(pin2) + t(HCL) ≤ 4 nanometers and t(HCL) ≥ 0.5 nanometers, in which tm(pin1) indicates the thickness of the pined layer constituting Synthetic AF, tm(pin2) indicates the thickness of the another pinned layer constituting it, and t(HCL) indicates the thickness of the nonmagnetic high-conductivity layer (in terms of the Cu layer having a specific resistance of 10 μΩcm). The condition of 0.5 nanometers ≤ tm(pin1) - tm(pin2) + t(HCL) is for the limit for the bias point of around 30 %, or that is, for the asymmetry of +10%; and the condition of tm(pin1) - tm(pin2) + t(HCL) ≤ 4 nanometers is for the limit for the bias point of around 50 %, or that is, for the asymmetry of -10 %.

"tm(pin1) - tm(pin2)" indicates the magnetic thickness

of the pinned layer in terms of NiFe with Ms of 1T. For example, in a Synthetic AF structure of PtMn/ 2 nm CoFe/0.9 nm Ru/2.5 nm CoFe, the pinned layer thickness is (2.5 -2) × 1.8T = 0.9 nanometers. In the structure incorporating the single-layer pinned layer in the above-mentioned Comparative Cases, used is Ms×t of the single-layer pinned layer.

t(HCL) indicates the thickness of the nonmagnetic high-conductivity layer in terms of Cu. Where the nonmagnetic high-conductivity layer is of any others except Cu, its thickness could be determined in terms of Cu, based on the above-mentioned data of the specific resistance of the constituent component.

The condition of t(HCL) ≥ 0.5 nanometers is to define the lowermost limit of the thickness of the nonmagnetic high-conductivity layer indispensable for realizing high MR in the spin valve films in which the thickness of the free layer is smaller than 4.5 nanometers. More preferably, t(HCL) ≤ 3 nanometers. This is because, when the thickness of the nonmagnetic high-conductivity layer is larger than 3 nanometers, ΔRs will lower. Also preferably, tm(pin1) - tm(pin2) ≤ 3 nanometers. This is because, if the difference in the thickness between the upper and lower films of the pinned layer in Synthetic AF is larger than 3 nanometers, the thermal stability for the pinned magnetization of the pinned layer will lower.